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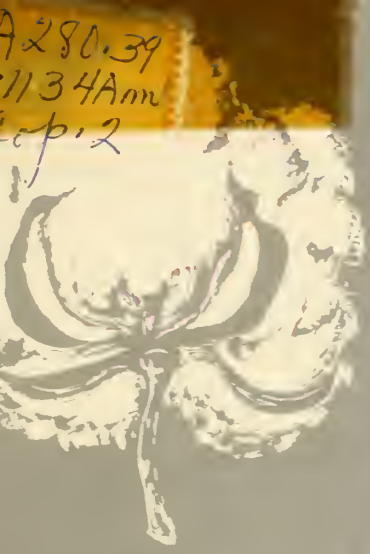

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A METHOD OF EVALUATING

SPINNING PERFORMANCE OF cotton

PRELIMINARY REPORT

U.S. DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Marketing Research Division

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A METHOD OF EVALUATING SPINNING PERFORMANCE OF COTTON

Preliminary Report

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Marketing Research Division, AMS

INTRODUCTION

A practical test method for measuring the spinning performance of cotton has been needed for many years. The only reliable test for this performance has been a test for ends down (yarn breakage) per 1,000 spindle hours, which requires a large number of spinning spindles and several hundred pounds of cotton. Such time-consuming and expensive tests have their limitations in fully evaluating the spinning performance of cotton. The Cotton Division, in cooperation with the Marketing Research Division for several years has been interested in a short method.

A number of methods have been tried during the summers of the last 5 years in an effort to develop spinning performance tests. These approaches included direct comparisons with increased tension on the yarns by increasing spindle speeds, feeding double roving at spinning, feeding single roving at spinning, varying the weights of travelers, and exaggerated processing of slivers and rovings. The repeatability of all these tests was so poor that none of them appeared very promising. During the last year, however, a procedure was developed at the College Station, Texas, laboratory which does appear to have possibilities of being refined into an excellent test method for obtaining the spinning performance of cotton from a small sample.

The method proposed in this preliminary report is based on the common knowledge that finer yarn numbers spun from the same cotton under the same organization and conditions produce a greater number of spinning-end breakages per hour. A series of yarn numbers are spun to obtain the relationship between yarn number and number of end breakages. The point where the trend line of this relationship intersects an arbitrary number of the end breakages line is defined as the "spinnable limit." Approximately 10 pounds of cotton are required for these tests on medium-staple cotton, slightly more being required for shorter staples and slightly less for longer staples. Such a test has many uses, and it measures a property of cotton that has not heretofore been measured from such a small amount of cotton. A practical use would be to measure the effect of harvesting, ginning, or any manufacturing process, before spinning, on the spinning performance of the cotton.

PROCEDURE

It is essential that the processing equipment used in this test method be in good mechanical condition. The preparatory processes of opening, picking, carding, drawing, and roving must be set up and operated so that uniform roving is provided for the performance tests made at the spinning process. The 84 spindles used in the test and the creel, rolls, rings, etc., must also be set up and operated as precisely as possible in order to obtain uniform and reproducible results. The organization to use in performing the tests as outlined in this report is based on carded yarn spinning tests through the roving process as performed routinely in the laboratories of the Cotton Division. 1/ The method is applicable to other organizational setups, but the results obtained would probably be on a different level.

In running the performance test, a number of variables must be held constant in order to obtain comparable results, because of their effect on spinning-end breakage. The same spindle speed, twist multiplier, and relative traveler size must be used on each yarn number for all cottons being compared. A standard spindle speed of 8500 revolutions per minute is proposed for all cottons and all yarn numbers. Standard twist multipliers of 4.40 for short-staple cottons, 4.00 for medium-staple cottons, and 3.80 for long-staple cottons are also proposed. After the standard spindle speed and twist multipliers are selected, however, there is still a problem in controlling variables. The finest adjustments that can be made are 1 tooth in the twist gear for twist, 1 tooth in the draft gear for draft, and 1 number for the weight of the traveler. It is evident, then, that each twist gear and each traveler number is normally used for a range of yarn numbers, and the desired yarn numbers cannot be spun precisely.

Because of these variables, it is necessary to spin yarn numbers as near as possible to the center of the range for both traveler number and twist gear in order to obtain reproducible results. To do this, the yarn number in the middle of the range used for each traveler number is selected as a starting point (table 1). The twist gears are then calculated for each of these middle yarn numbers from the twist multiplier selected and the twist constant of the spinning frame by applying the following formula:

$$\text{Twist gear} = \frac{\text{Twist constant}}{\text{Twist multiplier}} \times \sqrt{\text{Middle yarn number}}$$

These calculations are rounded to the "nearest" whole tooth in the twist gear and the closest yarn number to the center of the range is calculated by applying the following formula:

$$\text{Yarn number} = \left(\frac{\text{Twist constant}}{\text{Twist multiplier} \times \text{twist gear}}\right)^2$$

1/ U. S. Dept. Agr., Agr. Mktg. Serv., Cotton Div., AMS No. 16, Cotton Testing Service, February 1955.

Table 1.--Travelers used, range of yarns spun, and closest yarn number to the center of the range for both travelers and twist gears based on a twist multiplier of 4.00

Traveler size	Range of yarns spun			Teeth in twist gear 1/	Closest yarn to center of range 2/
	Low	Middle	High		
9/0	36.0	37.0	37.9	40	37.5
10/0	38.0	39.0	39.9	39	39.4
11/0	40.0	41.0	41.9	38	41.6
12/0	42.0	43.0	43.9	37	43.8
13/0	44.0	45.5	46.9	36	46.3
14/0	47.0	48.5	49.9	35	49.0
15/0	50.0	52.5	54.9	34	51.9
16/0	55.0	57.5	59.5	33	55.0
17/0	60.0	62.5	64.5	31	62.4
18/0	65.0	67.5	69.5	30	66.7
19/0	70.0	72.5	74.5	29	71.3
20/0	75.0	77.5	79.5	28	76.5
21/0	80.0	82.5	84.5	27	82.3
22/0	85.0	87.5	89.5	26	88.7

1/ $\text{Twist gear} = \frac{\text{Twist constant of spinning frame}}{\text{Twist multiplier} \times \sqrt{\text{middle yarn no.}}}$

2/ $\text{Yarn number} = \left(\frac{\text{Twist constant}}{(\text{Twist multiplier} \times \text{twist gear})}\right)^2$

Approximately 12 pounds of cotton is processed into 2.50 hank roving for short-staple cottons, 10 pounds into 3.25 hank roving for medium-staple cottons, or 8 pounds into 4.50 hank roving for long-staple cottons. The roving for each lot is divided equally on 84 bobbins at the roving process. Broken ends in the roving are not spliced because they may cause a broken end at the spinning which would be counted as a normal end down. The 84 bobbins of roving are creeled singly in the spinning frame to be used in the performance tests.

A trial run of approximately 150 yards is made on the spinning frame after it is set up for the closest yarn number, as calculated in table 1, which is estimated to be below the spinnable limit of the cotton being tested. If the spinnable limit is overestimated (ends down are excessive), this material should be discarded and a heavier yarn number selected and substituted. Skeins (120 yards) of yarn from 13 bobbins are sized by reeling and weighing. The nearest draft gear is calculated for the desired yarn number by inverse proportion from the trial sizing and trial draft gear. The calculated draft gear is installed to produce the desired yarn number as closely as possible, and the ring rail is positioned so as to wind the yarn near the middle portion of the bobbin. The spinning frame is now ready for the spinning performance tests, which consist of a 15-minute warmup period and a 1-hour run for several of the closest yarn numbers as calculated in table 1.

The number of spinning-end breakages are counted for the hour run on each yarn number and are recorded on a work sheet along with other pertinent data (fig. 1). A sizing of 2 full skeins (240 yards) of yarn from each of 13 bobbins is made for the actual yarn number recorded. This sizing is also used as the trial sizing for the next yarn number. Successively finer yarn numbers are spun and the end breakages versus yarn number relationship is plotted for each yarn number (fig. 2).

When 4 yarn numbers are produced with end breakages in the general range of 10 to 50 ends down per 1-hour run and the plotted points show that the relationship is practically linear, a trend line is drawn on the chart. The yarn number at which this trend line intersects the 20 ends down per 1-hour line is considered to be the spinnable limit of the cotton as determined by this method. The results of the tests may be expressed either as spinnable limit in terms of yarn number or they may be converted to a spinnability index when a control sample is used. The spinnability index is obtained by dividing the spinnable limit yarn number of each lot by the value for the control lot and multiplying by 100.

Precautions are necessary in carrying out the spinning performance test. The same travelers cannot be used for two different runs. When a repeat run is necessary to obtain the correct yarn number, new travelers must be used because of the difference in tension or drag. All yarn numbers being spun either on the light or the heavy side of the center of the range will also affect the results. In selecting the draft gear to use, care must be used to get some numbers on the light side and some on the heavy side. If this is not possible, then the fact that the numbers are on the light or heavy side of the center of the range should be considered by drawing the trend line to compensate for the difference in level of the results.

SPINNING PERFORMANCE WORK SHEET

Laboratory _____ Date _____

Test _____ Test No. _____

Traveler size	Twist gear (4.0 TM)	Yarn number desired	Draft gear used	Processing time Start	Processing time Finish	Number of spinning end breakages Left	Right	Total	Yarn number made
9/0	40	37.5							
10/0	39	39.4							
11/0	38	41.6							
12/0	37	43.8							
13/0	36	46.3							
14/0	35	49.0							
15/0	34	51.9							
16/0	33	55.0							
17/0	31	62.4	41	8:15	9:15	5	1	6	62.3
18/0	30	66.7	38	9:40	10:40	12	2	14	68.7
19/0	29	71.3	37	11:05	12:05	7	9	16	70.6
20/0	28	76.5	34	1:15	2:15	11	15	26	75.7
21/0	27	82.3	32	2:40	3:40	17	24	41	81.6
22/0	26	88.7							

Figure 1.--Example of data work sheet used in making spinning performance tests.

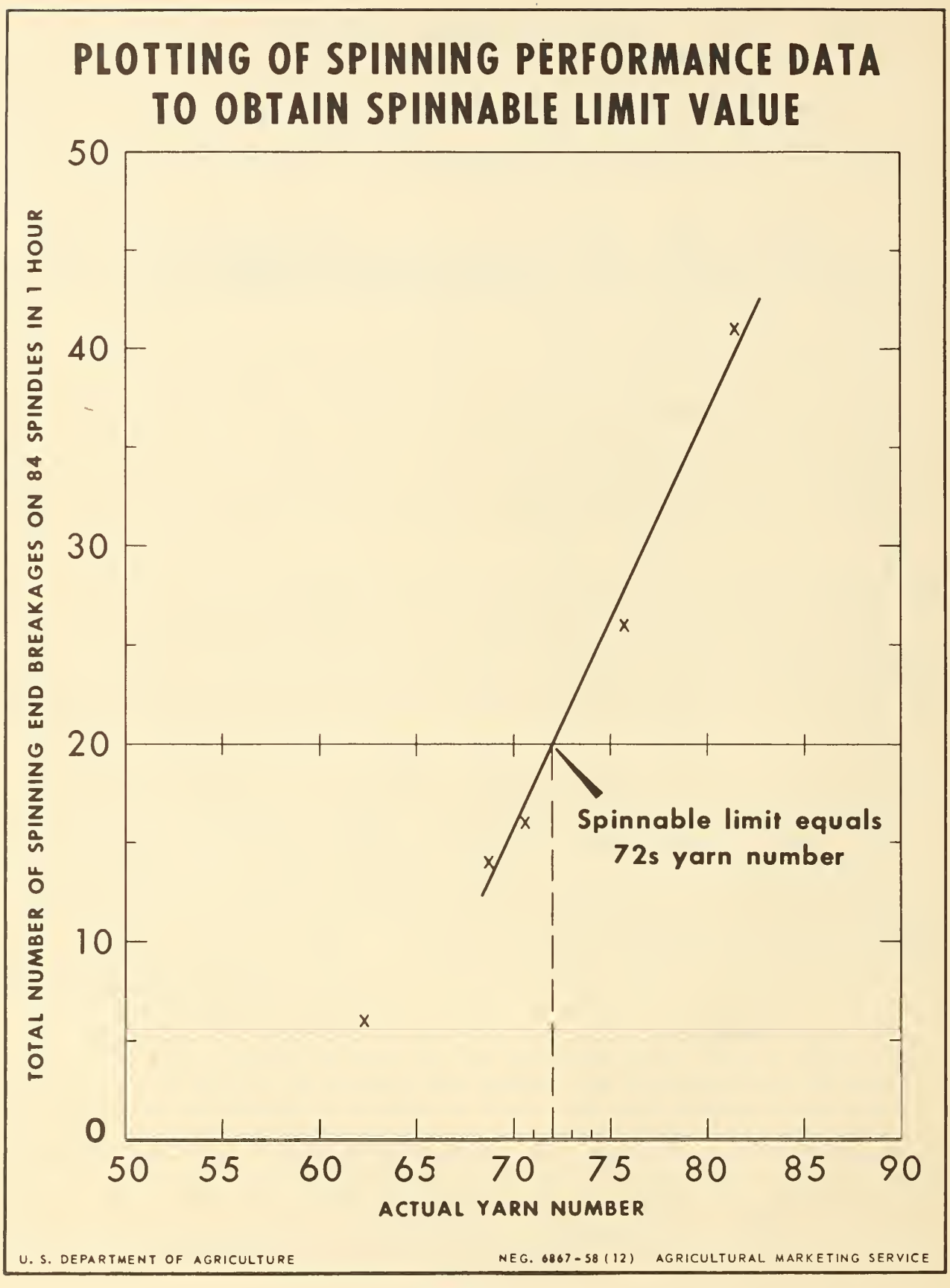
PLOTTING OF SPINNING PERFORMANCE DATA
TO OBTAIN SPINNABLE LIMIT VALUE
TOTAL NUMBER OF SPINNING END BREAKAGES ON 84 SPINDLES IN 1 HOUR
50
40
30
20
10
0
50
55
60
65
70
75
80
85
90
ACTUAL YARN NUMBER
Spinnable limit equals
72s yarn number
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Figure 2

EXPERIMENTAL RESULTS

This test method for spinning performance has been applied to the residue cotton from routine small-scale spinning tests at the College Station, Texas, laboratory for a number of cottons. A limited number of repeat tests were performed on several cottons and a limited inter-laboratory test was performed on two of the cottons normally used for check purposes. It is estimated from these tests that the spinnable limit results are reproducible to well within plus or minus two yarn numbers at the same laboratory. The results obtained at different laboratories were on different levels, but they showed the same general relationship between the different cottons being tested.

The problem of reproducibility of the results over a period of time at the same laboratory and between laboratories will require further work. The method is useful in its present stage of development, however, for comparing the spinning performance of different cottons on a relative basis by using control or base lots. It was used in this manner on a study of cottons receiving varying gin treatments. The results of its application in this study are reported to illustrate its application.

GIN TREATMENT STUDY

Twelve lots of cotton,harvested and ginned in the Tulare, Calif., area, were selected for the ginning-spinning study. The 12 lots represented 12 different gin conditions but were identified only in code. All 12 lots of cotton were processed and the results reported as a spinnability index using cotton No. 1 as the control lot, since it had the highest spinnable limit value at the level of ends down per hour specified in the procedure. The results obtained on these cottons are shown in descending order in figure 3 and table 2.

It can be noted that differences were obtained among the 12 cottons tested. The results indicate that the various treatments have different effects on the spinning performance of cotton in that there are practically 12 different levels of values obtained on this group of cottons.

As indicated earlier, this is a preliminary report and further work to improve the method is contemplated. The pilot plant facility being established cooperatively by the Agricultural Marketing Service, United States Department of Agriculture, and Clemson College will be helpful in further development. Processing results for large-scale lots will be provided by this facility, which can be used in further evaluating and refining the small-scale method.

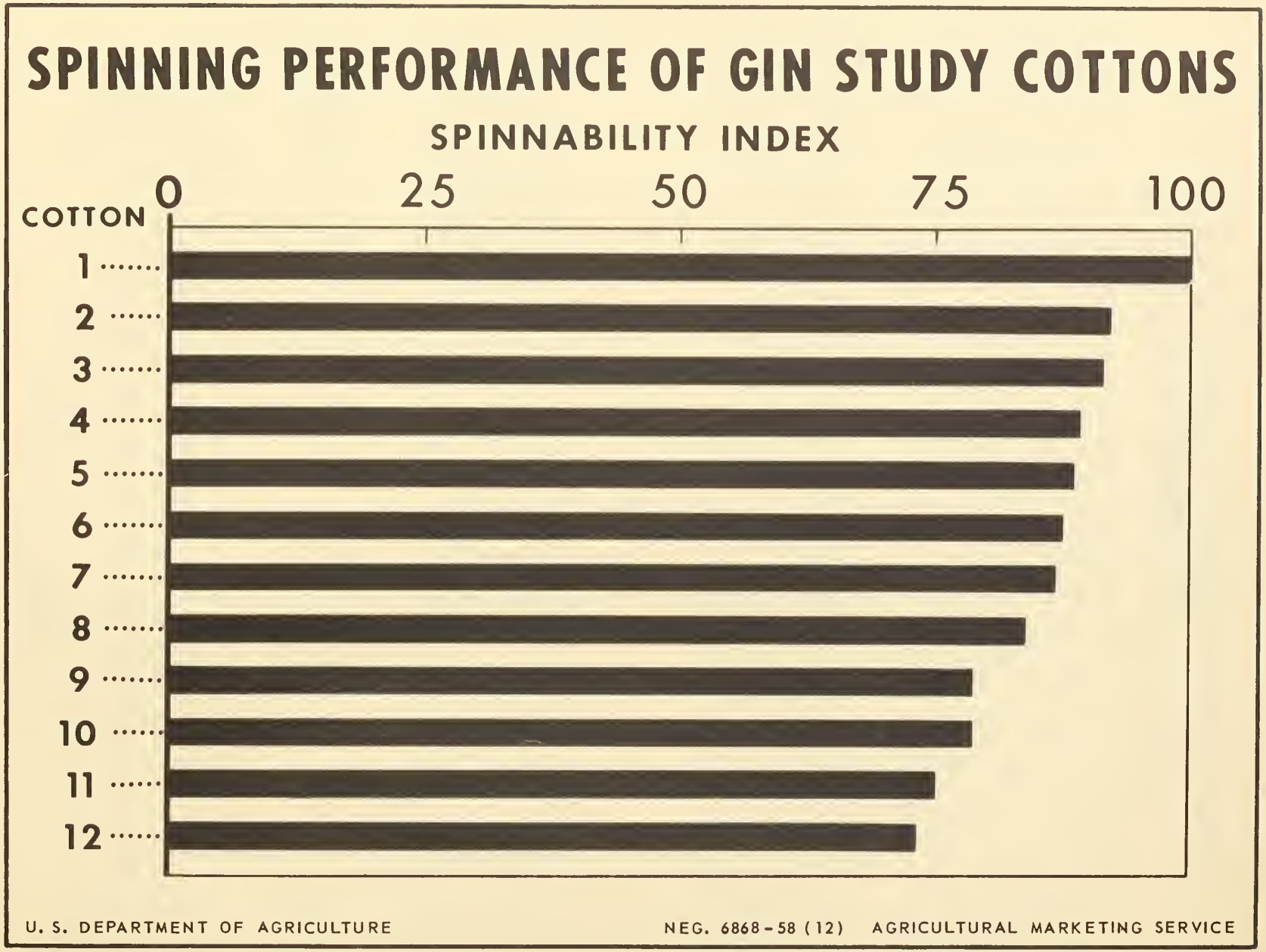
SPINNING PERFORMANCE OF GIN STUDY COTTONS
SPINNABILITY INDEX
0
25
50
75
100
COTTON
1
2
3
4
5
6
7
8
9
10
11
12
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Figure 3

Table 2.--Gin treatment study results showing spinnable limits and spinnability index values for cotton processed

Cotton	Spinnable limit 1/ (yarn number)	Spinnability index 2/
1 3/	86.0	100.0
2	79.0	91.9
3	78.5	91.3
4	76.5	89.0
5	76.0	88.4
6	75.0	87.2
7	74.5	86.6
8	72.0	83.7
9	67.5	78.5
10	67.5	78.5
11	64.5	75.0
12	63.0	73.3

1/ Yarn number required to produce 20 ends down/hour.
2/ Index based on control cotton's spinnable limits.
3/ Cotton used as control.

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